Clinical Update

Naval Postgraduate Dental School
National Naval Medical Center
8901 Wisconsin Ave
Bethesda, Maryland 20889-5600

Vol. 29 , No. 4 2007

Radiation safety revisited

Lieutenant Commander James K. Burnham, DC, USN and Commander William J. Lyons, DC, USN

Introduction

Radiographs are an essential component of the patient examination and proper diagnosis and management of dental disease. Although the precise radiation risk in the dental setting is difficult to accurately assess, some risk does exist. The Environmental Protection Agency (EPA) is responsible for providing periodic reports addressing diagnostic radiation exposure and protection guidelines for federal agency and Department of Defense healthcare facilities. In November of 2006, the EPA held the first meeting of an interagency working group tasked with revising the current federal guidance.[1] Significant advances in technology have occurred in medical and dental imaging since the original report was issued in 1976. The purpose of this publication is to provide updated information on the most recently proposed recommendations from the National Council on Radiation Protection and Measurements (NCRP), Report Number 145, "Radiation Protection in Dentistry,"[2] which will be included in the future revision of federal guidance. Although the new federal report is not anticipated to be ready for signature by the President until 2008, the recommendations of NCRP Report 145 should be implemented now to ensure optimal safety for our patients and staff.

Radiation protection philosophy

Three basic principles provide the foundation for radiation protection: 1. Justification—the benefit of radiation exposure outweighs any accompanying risk. 2. Optimization—Total exposure remains as low as reasonably achievable (ALARA principle), and 3. Dose limitation—Dose limits are applied to each individual to ensure that no one is exposed to an unacceptably high risk.

All persons are exposed to background radiation in their daily lives. The mean effective dose from all sources in the United States is estimated to be approximately 3.6 mSv (millisievert) per year of which 3.0 mSv is from naturally-occurring background sources. Most of the remaining exposure (~0.6 mSv) comes from the healing arts of which dental radiographs contribute approximately one percent.[3] Although this direct dose is small, it can potentially produce biologically significant changes.

Radiation protection guidelines

The specific radiation protection goal should be to obtain the required clinical information while avoiding any unnecessary exposure. To facilitate this goal the American Dental Association in conjunction with the Department of Health and Human Services developed general guidelines to serve as an adjunct to the dentist's professional judgment of how to use diagnostic imaging for each patient.[4] These guidelines (23 pages) are available for download at: http://www.fda.gov/cdrh/radhealth/adaxray.html.

Who can order dental radiographs? Only dentists and physicians are qualified by education, licensure and credentials to prescribe radiographic examinations and to evaluate and interpret the images produced. Furthermore, these procedures are done only after completing a clinical history and physical examination of a patient, with the subsequent determination of a reasonable expectation of a health benefit to the patient.

Radiation protection optimization - what's new?

Patient exposure per intraoral film as measured at skin entry has been reduced significantly since the early years of dental radiography. These reductions have been accomplished by improvements in equipment, operating procedures, and film/image receptors. NCRP Report 145 has two new recommendations that together could decrease entrance skin exposure up to ten-fold.

Image receptors: Faster film (E-speed) or digital receptors can result in a two-fold decreased entrance skin exposure. Recommendation: **Film slower than E-speed shall not be used for intraoral radiography.** Note: in the past E-speed films exhibited decreased contrast and higher sensitivity to processing conditions than was found with D-speed film. These problems have been corrected and current E-speed film can be used with no degradation of diagnostic information.

Rectangular collimation: Rectangular collimation to the size of the receptor reduces the effective dose to the patient by a factor of four to five. Recommendation: **Rectangular collimation of the x-ray beam shall be routinely used for periapical radiography.** Positive beam-receptor alignment with film positioning devices obviously becomes critical to achieving quality periapical radiographs. The recommendation does not apply at present to **bitewing** radiographs as the alignment issue remains problematic in many cases. Also, the size 3 bitewing film utilized in the military exceeds the dimensions of the recommended rectangular collimators and precludes their use. The above recommendation may be relaxed in the cases where anatomy or the inability of the patient to cooperate makes beam-receptor alignment awkward or impossible for individual projections. Likewise, the tube head should achieve a stable position, free of drift and oscillation within one second after its release at the desired position. If drift occurs during the one second after its release, it can be no greater than 0.5 centimeters.

Extraoral radiography: Recommendation: High-speed (400 or greater) rare earth film-screen systems or digital imaging systems of equivalent or greater speed shall be used. The same requirement applies to panoramic and cephalometric radiography. See Table 1.

Leaded aprons: Leaded aprons were recommended for patients in dentistry when dental x-ray equipment was much less sophisticated and films were much slower than current standards. Gonadal doses resulting from scatter radiation arising within the patient's body while using current state-of-the-art technology for panoramic or full-mouth radiographs are not significantly improved by the use of lead aprons. Consequently, technological and procedural improvements have eliminated the requirement for the leaded apron, provided all of the above recommendations are rigorously followed. The report notes that some patients have come to expect

the apron and may request that it be used. However, the report continues: "its use remains a prudent but not essential practice." [2]

Thyroid shields: The thyroid gland is among the most sensitive organs to radiation-induced tumors, especially in children. Recommendation: **Thyroid shielding shall be provided for children, and should be provided for adults, when it will not interfere with the examination**. Shields designed for thyroid protection usually interfere with panoramic exposures. Note: all leaded protective shields should be visually inspected for defects at monthly intervals or more frequently if they are damaged. At least once per year a fluoroscopic examination for hidden defects should be performed.

Personal dosimeters: No individual is permitted to receive an occupational effective dose in excess of **50 mSv** per year. The monitoring of individuals for occupational radiation exposure is not required in dentistry unless an individual is anticipated to exceed a threshold dose of **1 mSv per year**. Personal dosimeters have not been required in Navy dentistry for many years as the Naval Dosimetry Center has decades of data documenting dental occupational exposures far below the 1 mSv per year threshold. EXCEPTION: Personal dosimeters are required for known pregnant occupationally-exposed personnel.

Optimization of exposures: If using a digital system, familiarity with image enhancement and manipulation is required. For maximum diagnostic yield at minimum exposure, image evaluation and interpretation is best carried out in a dark, quiet atmosphere free from distraction. [5]

Radiation protection and the operator

It is a fundamental principle of radiation protection that no one other than the patient undergoing the radiographic procedure should be in the room at the time of exposure. As well, neither the operator nor the assistant should restrain uncooperative patients or hold the tube head or film/image receptor. If a member of the public (e.g. family member or guardian of the patient) must restrain the patient, or hold the tube head or film/image receptor, then they should be provided protective shields such as leaded aprons, leaded thyroid collars and/or leaded gloves. Other means of protection for the operator are physical barriers, appropriate distances, and proper film and patient positioning. Physical barriers should be a major part of construction design when building or updating existing facilities. These barriers should ideally allow the operator to maintain visual contact and communication with the patient throughout the procedure. In the absence of a physical barrier, it is recommended that the operator remain a minimum of 2 meters from the tube head and at a 45 degree angle from the primary beam as it exits the patient during the exposure.[6]

Conclusion

Radiation safety is important and requires continued effort and reinforcement. We as dentists are the experts and must be aware of radiation protection program requirements. Healthcare facilities that conduct their radiology practices in accordance with the recommendations in NCRP Report 145 can expect to obtain maximum oral health benefit for their patients while effectively minimizing radiation exposure to the patient, the operator, and the public.

Information on NCRP publications may be obtained from the NCRP website (http://www.ncrp.com) or by telephone (800-229-2652/ ext. 25).

Table 1. Conventional imaging radiation comparisons

Radiographic exam	Effective dose (mSv) per exam
Dental Panoramic*	.007
Cephalometric*	.017
FMX ANSI F speed	.026
FMX ANSI E speed	.033
FMX ANSI D speed*	.081
Skull	.110
CT Head	1.110
Background	3.000
Head and neck radiation	6×10^8

*Reductions of 50-90% (depending on the particular manufacturer and system components) can be expected with the use of digital imaging systems.

References

1. Federal Guidance Report No. 9: Radiation Protection Guidance for Diagnostic X-rays. EPA Interagency Working Group on Medical Radiation. October 1976.
2. National Council on Radiation Protection and Measurements (NCRP). Radiation Protection in Dentistry Report 145. Bethesda, MD: NCRP Publications, 2003.
3. Aroua A, Burnand B, Decka I, Vader JP, Valley JF. Nation-wide survey on radiation doses in diagnostic and interventional radiology in Switzerland in 1998. Health Phys 2002 Jul; 83(1):46-55.
4. American Dental Association. The selection of patients for dental radiographic examinations. 2004;1-23. http://www.ada.org/prof/resources/topics/topics_radiography_examinations.pdf. Accessed on May 10, 2007.
5. Wuehrmann AH. Radiation hygiene and its practice in dentistry as related to film viewing procedures and radiographic interpretation. Council on Dental Materials and Devices. J Am Dent Assoc 1970 Feb;80(2):346-56.
6. de Haan RA, van Aken J. Effective dose equivalent to the operator in intra-oral dental radiography. Dentomaxillofac Radiol. 1990 Aug;19(3):113-8.

Lieutenant Commander Burnham is a third year resident in the Periodontics program at the Naval Postgraduate Dental School. Commander Lyons is a faculty member in the Oral Medicine Department at the Naval Postgraduate Dental School.

The views expressed in this article are those of the authors and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the U.S. Government.

Note: The mention of any brand names in this *Clinical Update* does not imply recommendation or endorsement by the Department of the Navy, Department of Defense, or the US Government.

A universal collimator produced by Rinn Corporation may be obtained at a government cost of approximately $59 per unit (part #54-0853). To obtain the universal collimator, contact: Rinn Corp. Products for Dental Radiography at 1-800-323-0970 or 1-847-742-1115.